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Faculty of commerce

Alexandria University

Debottlenecking of a Batch Tire compound production

"Case Study: Tire Compound Manufacturing"

Submitted In partial fulfillment of the requirements for the degree of

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Abstract

Global competitive pressures are causing organization to find ways better to meet the needs of their customer, to reduce cost, and increase productivity. In batch plants, when trying to increase annual capacity, bottlenecks faced and as every production line have one or more bottleneck areas that limit overall performance. Each of these production limitations will add up to give a larger cumulative negative effect – on machine speed and on overall process efficiency. Those bottlenecks limit the amount of production produced. In case of tire, compound mixing bottlenecks limit the number of batches that can process per production period. In this work, bottleneck analysis and capacity studies present in order to identify and improve equipment and work setup related bottlenecks of the batch production line. The study prioritized the problem solutions, and plotted a clear, cost effective course toward the elimination of those bottlenecks in batch processing and explained the strategies for eliminating them. The debottlenecking decision-making process based on a set of operation-related variables that used to indicate the presence of bottlenecks and hence constructing an effective counter measure. The implementation of the suggested methodologies demonstrated with the use of a Banbury –rubber mixing-example at January 2008.

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Part I

Chapter (1)

1. Introduction

It has become increasingly important for companies to respond fast to market demands and be able to utilize the full capacity of existing equipment before purchasing of additional equipment becomes the only option. Every production line has one or more bottleneck areas that limit overall performance. Each of these production limitations will add up to give a larger cumulative negative effect on machine speed and on overall process efficiency. Therefore, Capacity analysis and planning is one of the most challenging subjects for the management to maximize their profitability by running up to unit limits or bottlenecks.

2. Study objective

Granting high productivity levels to meet market needs in terms of volume variations. The case is volume growth; and to show a better understanding of the conceptual frameworks, decisions that can drive ABC company forward into a turbulent, changing market.

2.1 Debottlenecking

No matter what the bottleneck is, there are often minor changes that can alleviate the restrictions. Incremental rather than sudden Debottlenecking can significantly improve an existing facility's capacity and profitability. When a facility management team is looking for alternative expansion schemes to increase the current production rate as the production capacity limited the current operating condition and equipment setup. A Debottlenecking study will needed for an increase in production. In addition, the Debottlenecking study will assist the management team in future expansion plans. The ultimate goal is to create a solid base on which to build production line speed and efficiency improvement decisions. Benefits from these types of analysis are to be expected at all stages of process development, from process conception all the way to manufacturing.

A problem of particular interest on the manufacturing floor is that of the tire production process –Figure 1- debottlenecking, i.e. the identification and removal of obstacles in the attempt to increase plant throughput. In batch processes, however, multiple operations share the same equipment; therefore, scheduling conflicts might also create obstacles in the attempt to increase throughput. Batch scheduling can be formulated and solved as an optimization problem. In fact, the field has been under intense investigation for a few decades now and many different approaches have been formulated based on rule-based, artificial intelligence or model-based methods (Reklaitis, Pekny & Joglekar, 1997 for a review.)

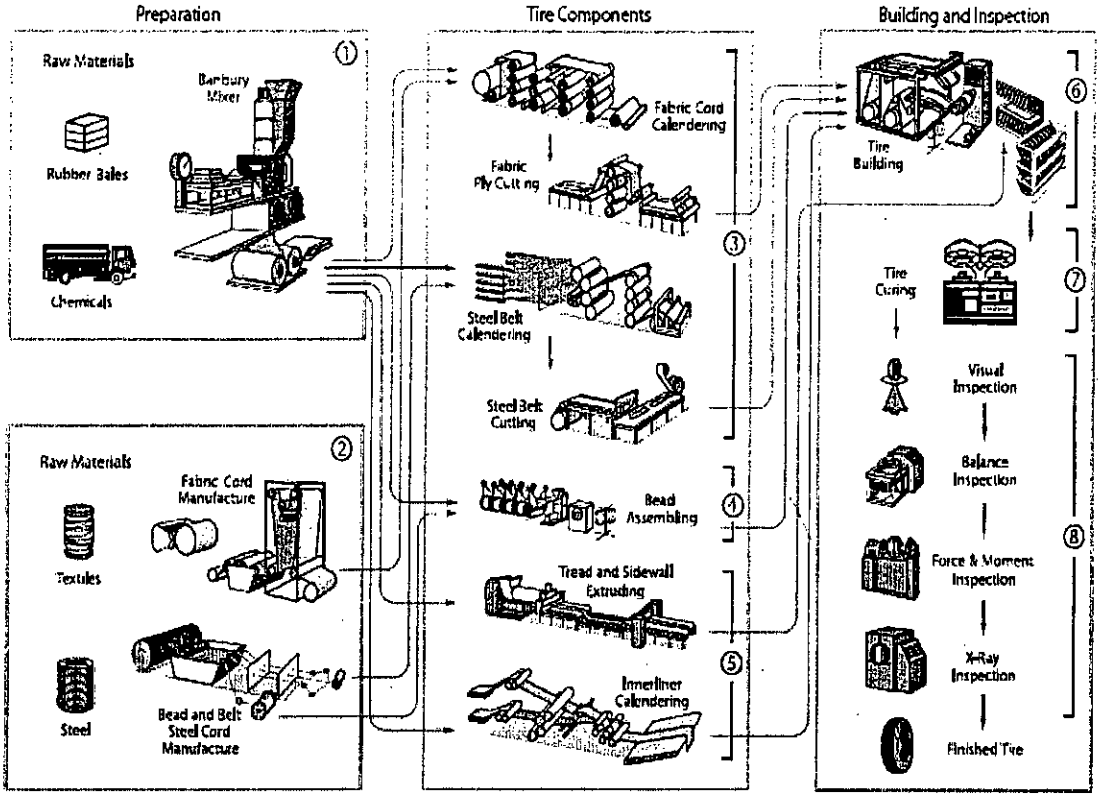

Figure 1 tire production diagram (www. Maxx.com)

Software packages have also developed to facilitate the formulation and solution of batch scheduling. The use of such packages requires some familiarity with the underlying optimization concepts and usually involves significant simplifications on the process representation to render the problem mathematically tractable. Unlike an optimization-based approach, a simulation-based approach, although lacking mathematical rigor, offers the advantage of an uncompromised process representation that is under the control of the user. Performing throughput analysis on top of a detailed process model allows the identification of potential problems and solutions that would be missed by an optimization-friendly representation of the plant.

Simulation tools that are capable of tracking equipment time and capacity utilization can facilitate the identification of potential bottlenecks and guide the user in developing and evaluating alternative scenarios.

In this work, the concept of performing throughput analysis is introduced together with a systematic methodology for identifying and removing bottlenecks.

2.2 Debottlenecking Strategies

Assuming that a feasible batch schedule with a given assignment of procedures to equipment is initially available. Also that all the required information on equipment utilization, loading times and models how they vary with batch size are known. In view of the previous assumptions, the obvious strategy in the attempt to increase annual throughput is to increase the batch size until a size bottleneck is reached. Once a size bottleneck is reached, there are three alternatives to the further increase of the batch size:

1. Increase the number of cycles per batch for the limiting procedure and process by reducing the cycle time through eliminating the non-value added time.

2. Rearrange the equipment assignment so that equipment with larger capacity is utilized for the limiting procedure, or;

3. Introduce (buy or use available) new equipment.

The last solution is the least desirable because it involves capital investment. The decision to buy new equipment will have to be based on overall plant economic criteria, not simply on throughput considerations.

Increasing equipment capacity, (either by changing equipment assignment or introducing new equipment) becomes the only option if the loading time of the limiting procedure varies proportionally to batch throughput. In that case, any further increase in batch size will result in a proportional increase in effective batch time and the annual throughput will remain the same.[3]

In all other cases, the simplest solution is to increase the number of cycles per batch, by reducing the cycle time through eliminating the non-value added time either technical or machine cycle time.

Although not addressed in this work, resources (e.g. utilities, raw materials, labor, etc.) can also become throughput bottlenecks. As throughput in a batch plant is increased, the demand for resources increases. If a resource demand exceeds its maximum availability rate, a resource-related bottleneck is reached. (A. Koulouris et al. 2000)

OEE and capacity studies that can calculate equipment utilization and resource demand as a function of time can significantly facilitate the debottlenecking effort. This can be done either at the design stage where these tools can be used to sensibly size process equipment and utilities, or at the manufacturing level to improve plant performance.